SN5490A, SN5492A, SN5493A, SN54LS90, SN54LS92, SN54LS93, SN7490A, SN7492A, SN7493A, SN74LS90, SN74LS92, SN74LS93
DECADE, DIVIDE-BY-TWELVE AND BINARY COUNTERS

MARCH 1974—REVISED MARCH 1988

'90A, 'LS90 . . . Decade Counters

'92A, 'LS92 . . . Divide By-Twelve Counters

'93A, 'LS93 . . . 4-Bit Binary Counters

TYPES	TYPICAL POWER DISSIPATION
'90A	145 mW
'92A, '93A	130 mW
'LS90, 'LS92, 'LS93	45 mW

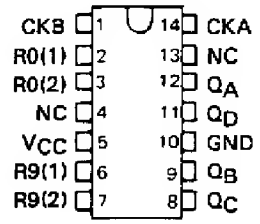
description

Each of these monolithic counters contains four master-slave flip-flops and additional gating to provide a divide-by-two counter and a three-stage binary counter for which the count cycle length is divide-by-five for the '90A and 'LS90, divide-by-six for the '92A and 'LS92, and the divide-by-eight for the '93A and 'LS93.

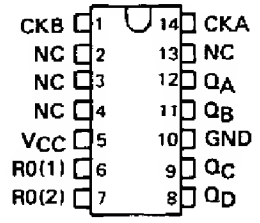
All of these counters have a gated zero reset and the '90A and 'LS90 also have gated set-to-nine inputs for use in BCD nine's complement applications.

To use their maximum count length (decade, divide-by-twelve, or four-bit binary) of these counters, the CKB input is connected to the Q_A output. The input count pulses are applied to CKA input and the outputs are as described in the appropriate function table. A symmetrical divide-by-ten count can be obtained from the '90A or 'LS90 counters by connecting the Q_D output to the CKA input and applying the input count to the CKB input which gives a divide-by-ten square wave at output Q_A.

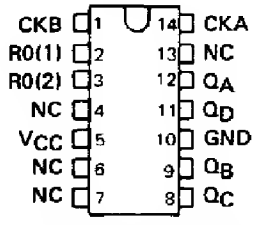
SN5490A, SN54LS90 . . . J OR W PACKAGE
SN7490A . . . N PACKAGE
SN74LS90 . . . D OR N PACKAGE
(TOP VIEW)



SN5492A, SN54LS92 . . . J OR W PACKAGE
SN7492A . . . N PACKAGE
SN74LS92 . . . D OR N PACKAGE
(TOP VIEW)



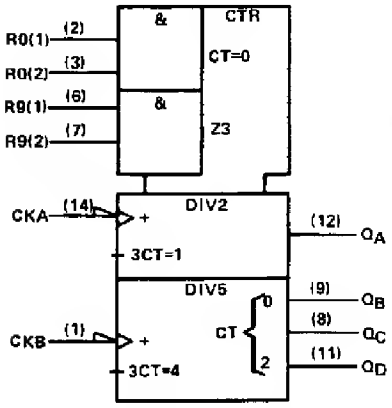
SN5493A, SN54LS93 . . . J OR W PACKAGE
SN7493 . . . N PACKAGE
SN74LS93 . . . D OR N PACKAGE
(TOP VIEW)



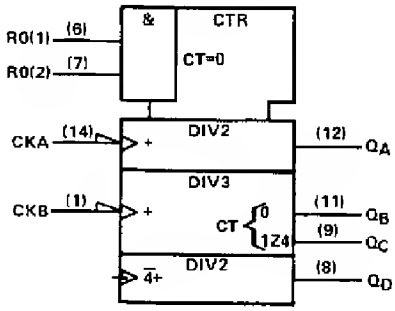
NC—No internal connection

logic symbols†

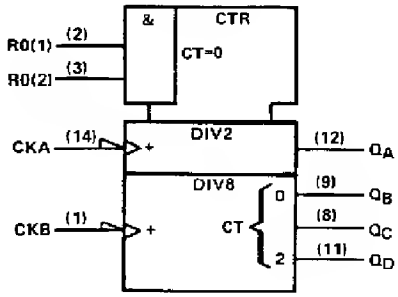
'90



'92



'93A, 'LS93



†These symbols are in accordance with ANSI/IEEE Std. 91-1984 and IEC Publication 617-12.

'90A, 'LS90
BCD COUNT SEQUENCE
(See Note A)

COUNT	OUTPUT			
	Q_D	Q_C	Q_B	Q_A
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	L	H	L	H
6	L	H	H	L
7	L	H	H	H
8	H	L	L	L
9	H	L	L	H

'90A, 'LS90
BI-QUINARY (5-2)
(See Note B)

COUNT	OUTPUT			
	Q_A	Q_D	Q_C	Q_B
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	H	L	L	L
6	H	L	L	H
7	H	L	H	L
8	H	L	H	H
9	H	H	L	L

'92A, 'LS92
COUNT SEQUENCE
(See Note C)

COUNT	OUTPUT			
	Q_D	Q_C	Q_B	Q_A
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	L	H	L	H
6	H	L	L	L
7	H	L	L	H
8	H	L	H	L
9	H	L	H	H
10	H	H	L	L
11	H	H	L	H

'90A, 'LS90
RESET/COUNT FUNCTION TABLE

RESET INPUTS				OUTPUT			
$R_{0(1)}$	$R_{0(2)}$	$R_{9(1)}$	$R_{9(2)}$	Q_D	Q_C	Q_B	Q_A
H	H	L	X	L	L	L	L
H	H	X	L	L	L	L	L
X	X	H	H	H	L	L	H
X	L	X	L	COUNT			
L	X	L	X	COUNT			
L	X	X	L	COUNT			
X	L	L	X	COUNT			

'92A, 'LS92, '93A, 'LS93
RESET/COUNT FUNCTION TABLE

RESET INPUTS		OUTPUT			
$R_{0(1)}$	$R_{0(2)}$	Q_D	Q_C	Q_B	Q_A
H	H	L	L	L	L
L	X	COUNT			
X	L	COUNT			

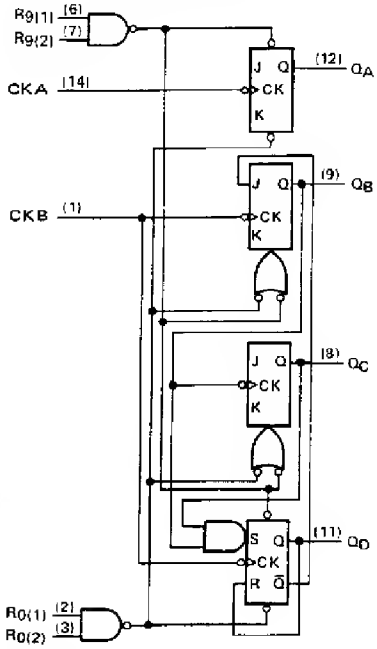
'93A, 'LS93
COUNT SEQUENCE
(See Note C)

COUNT	OUTPUT			
	Q_D	Q_C	Q_B	Q_A
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	L	H	L	H
6	L	H	H	L
7	L	H	H	H
8	H	L	L	L
9	H	L	L	H
10	H	L	H	L
11	H	L	H	H
12	H	H	L	L
13	H	H	L	H
14	H	H	H	L
15	H	H	H	H

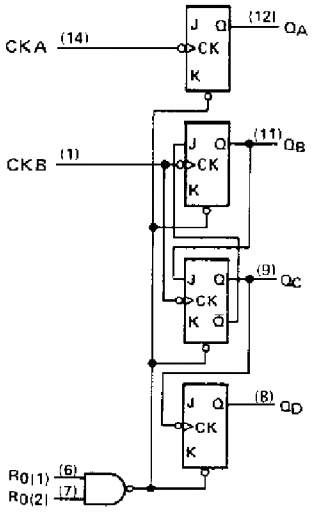
NOTES: A. Output Q_A is connected to input CKB for BCD count.
B. Output Q_D is connected to input CKA for bi-quinary count.
C. Output Q_A is connected to input CKB.
D. H = high level, L = low level, X = irrelevant

logic diagrams (positive logic)

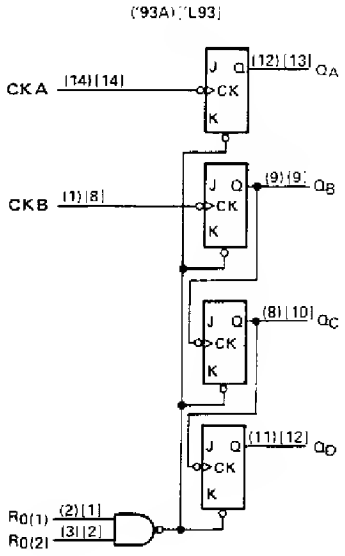
'90A, 'LS90



'92A, 'LS92



'93A, 'LS93

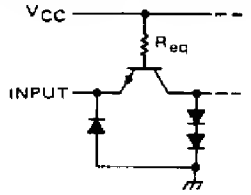


The J and K inputs shown without connection are for reference only and are functionally at a high level.
Pin numbers shown in ( ) are for the 'LS93 and '93A and pin numbers shown in [ ] are for the 54L93.

schematics of inputs and outputs

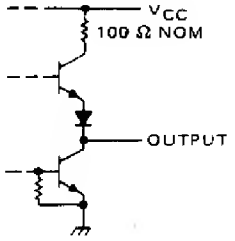
'90A, '92A, '93A

EQUIVALENT OF EACH INPUT



INPUT	R_{eq} NOM
CKA	2.5 kΩ
CKB ('90A, '92A)	1.25 kΩ
CKB ('93A)	2.5 kΩ
All resets	6 kΩ

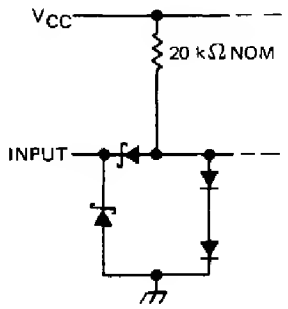
TYPICAL OF ALL OUTPUTS



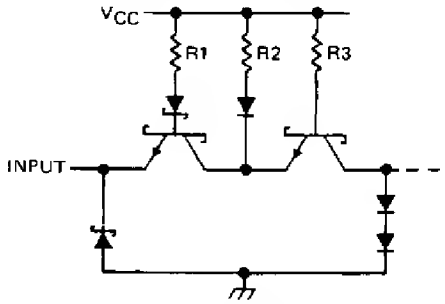
schematics of inputs and outputs (continued)

'LS90, 'LS92, 'LS93

EQUIVALENT OF EACH RESET INPUT

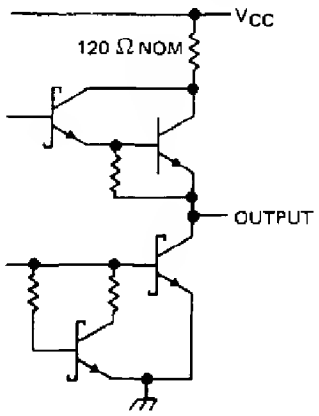


EQUIVALENT OF A AND B INPUTS



INPUT	NOMINAL VALUES R1	R2	R3
CKA	10 kΩ	10 kΩ	10 kΩ
CKB ('LS90, 'LS92)	6.7 kΩ	6.7 kΩ	5 kΩ
CKB ('LS93)	15 kΩ	15 kΩ	10 kΩ

TYPICAL OF ALL OUTPUTS



absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

Supply voltage, V_{CC} (see Note 1) . . . . . 7 V
Input voltage . . . . . 5.5 V
Interemitter voltage (see Note 2) . . . . . 5.5 V
Operating free-air temperature range: SN5490A, SN5492A, SN5493A . . . . . −55°C to 125°C
SN7490A, SN7492A, SN7493A . . . . . 0°C to 70°C
Storage temperature range . . . . . −65°C to 150°C

NOTES: 1. Voltage values, except interemitter voltage, are with respect to network ground terminal.
2. This is the voltage between two emitters of a multiple emitter transistor. For these circuits, this rating applies between the two R_0 inputs, and for the '90A circuit, it also applies between the two R_9 inputs.

recommended operating conditions

		SN5490A, SN5492A SN5493A			SN7490A, SN7492A SN7493A			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}		4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}				−800			−800	μA
Low-level output current, I_{OL}				16			16	mA
Count frequency, f_{count} (see Figure 1)	A input	0		32	0		32	MHz
	B input	0		16	0		16	
Pulse width, t_w	A input	15			15			ns
	B input	30			30			
	Reset inputs	15			15			
Reset inactive-state setup time, t_{su}		25			25			ns
Operating free-air temperature, T_A		−55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER†		TEST CONDITIONS†		'90A MIN	'90A TYP‡	'90A MAX	'92A MIN	'92A TYP‡	'92A MAX	'93A MIN	'93A TYP‡	'93A MAX	UNIT
V_{IH}	High-level input voltage			2			2			2			V
V_{IL}	Low-level input voltage					0.8			0.8			0.8	V
V_{IK}	Input clamp voltage	V_{CC} = MIN, I_I = −12 mA				−1.5			−1.5			−1.5	V
V_{OH}	High-level output voltage	V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = 0.8 V, I_{OH} = −800 μA		2.4	3.4		2.4	3.4		2.4	3.4		V
V_{OL}	Low-level output voltage	V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = 0.8 V, I_{OL} = 16 mA¶			0.2	0.4		0.2	0.4		0.2	0.4	V
I_I	Input current at maximum input voltage	V_{CC} = MAX, V_I = 5.5 V				1			1			1	mA
I_{IH}	High-level input current	V_{CC} = MAX, V_I = 2.4 V	Any reset			40			40			40	μA
			CKA			80			80			80	
			CKB			120			120			80	
I_{IL}	Low-level input current	V_{CC} = MAX, V_I = 0.4 V	Any reset			−1.6			−1.6			−1.6	mA
			CKA			−3.2			−3.2			−3.2	
			CKB			−4.8			−4.8			−3.2	
I_{OS}	Short-circuit output current§	V_{CC} = MAX	SN54'	−20		−57	−20		−57	−20		−57	mA
			SN74'	−18		−57	−18		−57	−18		−57	
I_{CC}	Supply current	V_{CC} = MAX, See Note 3			29	42		26	39		26	39	mA

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time.
¶Q_A outputs are tested at I_{OL} = 16 mA plus the limit value for I_{IL} for the CKB input. This permits driving the CKB input while maintaining full fan-out capability.
NOTE 3: I_{CC} is measured with all outputs open, both R_0 inputs grounded following momentary connection to 4.5 V, and all other inputs grounded.

switching characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER†	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	'90A			'92A			'93A			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
f_{max}	CKA	Q_A	C_L = 15 pF, R_L = 400 Ω, See Figure 1	32	42		32	42		32	42		MHz
	CKB	Q_B		16			16			16			
t_{PLH}	CKA	Q_A			10	16		10	16		10	16	ns
t_{PHL}					12	18		12	18		12	18	
t_{PLH}	CKA	Q_D			32	48		32	48		46	70	ns
t_{PHL}					34	50		34	50		46	70	
t_{PLH}	CKB	Q_B			10	16		10	16		10	16	ns
t_{PHL}					14	21		14	21		14	21	
t_{PLH}	CKB	Q_C			21	32		10	16		21	32	ns
t_{PHL}					23	35		14	21		23	35	
t_{PLH}	CKB	Q_D			21	32		21	32		34	51	ns
t_{PHL}					23	35		23	35		34	51	
t_{PHL}	Set-to-0	Any			26	40		26	40		26	40	ns
t_{PLH}	Set-to-9	Q_A, Q_D			20	30							ns
t_{PHL}		Q_B, Q_C			26	40							

†f_{max} = maximum count frequency
t_{PLH} = propagation delay time, low-to-high-level output
t_{PHL} = propagation delay time, high-to-low-level output

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

Supply voltage, V_{CC} (see Note 1) . . . . . 7 V
Input voltage: R inputs . . . . . 7 V
A and B inputs . . . . . 5.5 V
Operating free-air temperature range: SN54LS' Circuits . . . . . −55°C to 125°C
SN74LS' Circuits . . . . . 0°C to 70°C
Storage temperature range . . . . . −65°C to 150°C

NOTE 1: Voltage values are with respect to network ground terminal.

recommended operating conditions

		SN54LS90 SN54LS92 SN54LS93			SN74LS90 SN74LS92 SN74LS93			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}		4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}				−400			−400	μA
Low-level output current, I_{OL}				4			8	mA
Count frequency, f_{count} (see Figure 1)	A input	0		32	0		32	MHz
	B input	0		16	0		16	
Pulse width, t_w	A input	15			15			ns
	B input	30			30			
	Reset inputs	30			30			
Reset inactive-state setup time, t_{su}		25			25			ns
Operating free-air temperature, T_A		−55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER			TEST CONDITIONS†			SN54LS90 SN54LS92			SN74LS90 SN74LS92			UNIT
						MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IH}	High-level input voltage					2			2			V
V_{IL}	Low-level input voltage							0.7			0.8	V
V_{IK}	Input clamp voltage		V_{CC} = MIN,	I_I = −18 mA				−1.5			−1.5	V
V_{OH}	High-level output voltage		V_{CC} = MIN, V_{IL} = V_{IL}max,	V_{IH} = 2 V, I_{OH} = −400 μA		2.5	3.4		2.7	3.4		V
V_{OL}	Low-level output voltage		V_{CC} = MIN, V_{IL} = V_{IL} max,	V_{IH} = 2 V,	I_{OL} = 4 mA¶		0.25	0.4		0.25	0.4	V
					I_{OL} = 8 mA¶					0.35	0.5	
I_I	Input current at maximum input voltage	Any reset	V_{CC} = MAX,	V_I = 7 V				0.1			0.1	mA
		CKA	V_{CC} = MAX,	V_I = 5.5 V				0.2			0.2	
		CKB						0.4			0.4	
I_{IH}	High-level input current	Any reset	V_{CC} = MAX,	V_I = 2.7 V				20			20	μA
		CKA						40			40	
		CKB						80			80	
I_{IL}	Low-level input current	Any reset	V_{CC} = MAX,	V_I = 0.4 V				−0.4			−0.4	mA
		CKA						−2.4			−2.4	
		CKB						−3.2			−3.2	
I_{OS}	Short-circuit output current§		V_{CC} = MAX			−20		−100	−20		−100	mA
I_{CC}	Supply current		V_{CC} = MAX,	See Note 3	'LS90		9	15		9	15	mA
					'LS92		9	15		9	15	

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time, and duration of the short-circuit should not exceed one second.
¶Q_A outputs are tested at specified I_{OL} plus the limit value of I_{IL} for the CKB input. This permits driving the CKB input while maintaining full fan-out capability.
NOTE 3: I_{CC} is measured with all outputs open, both R_O inputs grounded following momentary connection to 4.5 V, and all other inputs grounded.

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER			TEST CONDITIONS†			SN54LS93			SN74LS93			UNIT
						MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IH}	High-level input voltage					2			2			V
V_{IL}	Low-level input voltage							0.7			0.8	V
V_{IK}	Input clamp voltage		V_{CC} = MIN,	I_I = −18 mA				−1.5			−1.5	V
V_{OH}	High-level output voltage		V_{CC} = MIN, V_{IL} = V_{IL} max,	V_{IH} = 2 V, I_{OH} = −400 μA		2.5	3.4		2.7	3.4		V
V_{OL}	Low-level output voltage		V_{CC} = MIN, V_{IL} = V_{IL} max	V_{IH} = 2 V,	I_{OL} = 4 mA¶		0.25	0.4		0.25	0.4	V
					I_{OL} = 8 mA¶					0.35	0.5	
I_I	Input current at maximum input voltage	Any reset	V_{CC} = MAX,	V_I = 7 V				0.1			0.1	mA
		CKA or CKB	V_{CC} = MAX,	V_I = 5.5 V				0.2			0.2	
I_{IH}	High-level input current	Any reset	V_{CC} = MAX,	V_I = 2.7 V				20			20	μA
		CKA or CKB						40			80	
I_{IL}	Low-level input current	Any reset	V_{CC} = MAX,	V_I = 0.4 V				−0.4			−0.4	mA
		CKA						−2.4			−2.4	
		CKB						−1.6			−1.6	
I_{OS}	Short-circuit output current§		V_{CC} = MAX			−20		−100	−20		−100	mA
I_{CC}	Supply current		V_{CC} = MAX,	See Note 3			9	15		9	15	mA

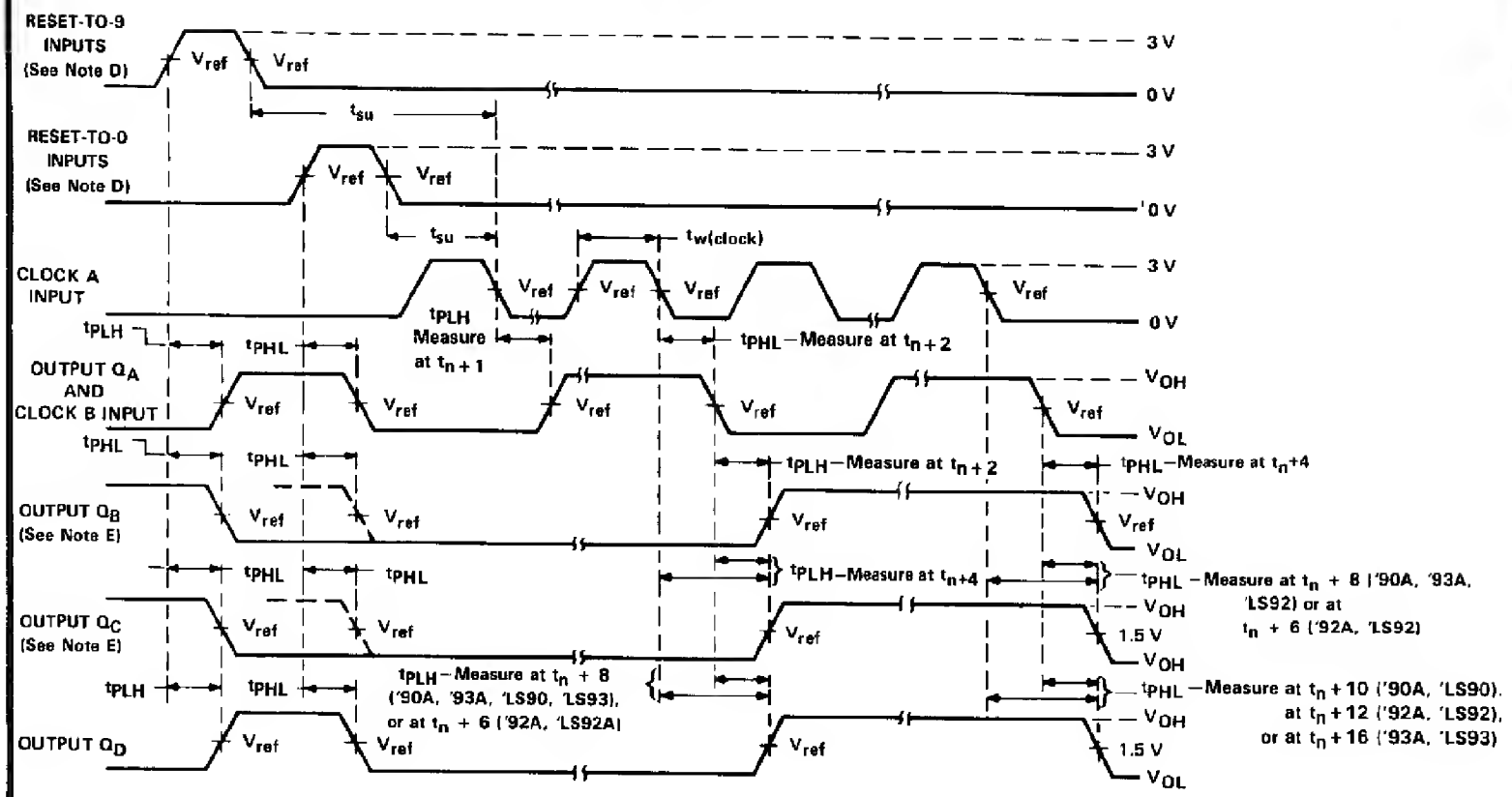
†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time, and duration of the short-circuit should not exceed one second.
¶Q_A outputs are tested at specified I_{OL} plus the limit value for I_{IL} for the CKB input. This permits driving the CKB input while maintaining full fan-out capability.
NOTE 3: I_{CC} is measured with all outputs open, both R_0 inputs grounded following momentary connection to 4.5 V, and all other inputs grounded.

switching characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER#	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	'LS90			'LS92			'LS93			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
f_{max}	CKA	Q_A	C_L = 15 pF, R_L = 2 kΩ, See Figure 1	32	42		32	42		32	42		MHz
	CKB	Q_B		16			16			16			
t_{PLH}	CKA	Q_A			10	16		10	16		10	16	ns
t_{PHL}					12	18		12	18		12	18	
t_{PLH}	CKA	Q_D			32	48		32	48		46	70	ns
t_{PHL}					34	50		34	50		46	70	
t_{PLH}	CKB	Q_B			10	16		10	16		10	16	ns
t_{PHL}					14	21		14	21		14	21	
t_{PLH}	CKB	Q_C			21	32		10	16		21	32	ns
t_{PHL}					23	35		14	21		23	35	
t_{PLH}	CKB	Q_D			21	32		21	32		34	51	ns
t_{PHL}					23	35		23	35		34	51	
t_{PHL}	Set-to-0	Any			26	40		26	40		26	40	ns
t_{PLH}	Set-to-9	Q_A, Q_D			20	30							ns
t_{PHL}		Q_B, Q_C			26	40							

#f_{max} = maximum count frequency
t_{PLH} = propagation delay time, low-to-high-level output
t_{PHL} = propagation delay time, high-to-low-level output

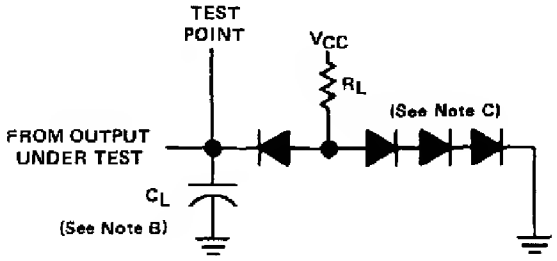
PARAMETER MEASUREMENT INFORMATION



NOTES: A. Input pulses are supplied by a generator having the following characteristics:
for '90A, '92A, '93A, $t_r \leq 5$ ns, $t_f \leq 5$ ns, PRR = 1 MHz, duty cycle = 50%, $Z_{out} \approx 50$ ohms;
for 'LS90, 'LS92, 'LS93, $t_r \leq 15$ ns, $t_f \leq 5$ ns, PRR = 1 MHz, duty cycle = 50%, $Z_{out} \approx 50$ ohms.
B. C_L includes probe and jig capacitance.
C. All diodes are 1N3064 or equivalent.
D. Each reset input is tested separately with the other reset at 4.5 V.
E. Reference waveforms are shown with dashed lines.
F. For '90A, '92A, and '93A; V_{ref} = 1.5 V. For 'LS90, 'LS92, and 'LS93; V_{ref} = 1.3 V.

FIGURE 1A

PARAMETER MEASUREMENT INFORMATION



LOAD CIRCUIT

NOTES: A. Input pulses are supplied by a generator having the following characteristics:
for '90A, '92A, '93A, $t_r \leq 5$ ns, $t_f \leq 5$ ns, PRR = 1 MHz, duty cycle = 50%, $Z_{out} \approx 50$ ohms;
for 'LS90, 'LS92, 'LS93, $t_r \leq 15$ ns, $t_f \leq 5$ ns, PRR = 1 MHz, duty cycle = 50%, $Z_{out} \approx 50$ ohms.
B. C_L includes probe and jig capacitance.
C. All diodes are 1N3064 or equivalent.
D. Each reset input is tested separately with the other reset at 4.5 V.
E. Reference waveforms are shown with dashed lines.
F. For '90A, '92A, and '93A: V_{ref} = 1.5 V. For 'LS90, 'LS92, and 'LS93; V_{ref} = 1.3 V.

FIGURE 1B

IMPORTANT NOTICE

Texas Instruments (TI) reserves the right to make changes to its products or to discontinue any semiconductor product or service without notice, and advises its customers to obtain the latest version of relevant information to verify, before placing orders, that the information being relied on is current.

TI warrants performance of its semiconductor products and related software to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are utilized to the extent TI deems necessary to support this warranty. Specific testing of all parameters of each device is not necessarily performed, except those mandated by government requirements.

Certain applications using semiconductor products may involve potential risks of death, personal injury, or severe property or environmental damage ("Critical Applications").

TI SEMICONDUCTOR PRODUCTS ARE NOT DESIGNED, INTENDED, AUTHORIZED, OR WARRANTED TO BE SUITABLE FOR USE IN LIFE-SUPPORT APPLICATIONS, DEVICES OR SYSTEMS OR OTHER CRITICAL APPLICATIONS.

Inclusion of TI products in such applications is understood to be fully at the risk of the customer. Use of TI products in such applications requires the written approval of an appropriate TI officer. Questions concerning potential risk applications should be directed to TI through a local SC sales office.

In order to minimize risks associated with the customer's applications, adequate design and operating safeguards should be provided by the customer to minimize inherent or procedural hazards.

TI assumes no liability for applications assistance, customer product design, software performance, or infringement of patents or services described herein. Nor does TI warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right of TI covering or relating to any combination, machine, or process in which such semiconductor products or services might be or are used.